Project Lead The Way® "Computer Integrated Manufacturing"
Technology Education – Applied Technology Education
Utah State Office of Education
CIP Code 210123

COURSE DESCRIPTION: This course teaches the fundamentals of computerized manufacturing technology. It builds on the solid-modeling skills developed in the Introduction to Engineering Design course. Students use 3-D computer software to solve design problems. They assess their solutions through mass propriety analysis (the relationship of design, junction, and materials), modify their designs, and use prototyping equipment to produce 3-Dmodels. The course includes these integrated concepts:

- Computer Modeling: Students use 3-D software for mass property analysis.
- Computer Numerical Control (CNC) Equipment: Students develop an understanding of the operating procedures and programming capabilities of machine tools.
- Computer-aided Manufacturing (CAM): Students convert computer-generated geometry into a program to direct the operation of CNC machine tools.
- Robotics: Student program robots to handle materials in assembly-line operations.
- Flexible Manufacturing Systems: Teams of students design manufacturing work cells and tabletop factories to solve complex problems that arise in integrating multiple pieces of computer-controlled equipment.

STANDARD & OBJECTIVES

210123.01 COMPUTER MODELING: STUDENTS USE 3-D SOFTWARE FOR MASS PROPERTY ANALYSIS.

210123.0101 Student will be able to demonstrate the ability to store, retrieve copy, and output drawing files depending upon system setup. (Fundamentals)
210123.0102 Students will be able to utilize instructor identified 2D computer sketching functions. (Fundamentals)
210123.0103 Students will be able to incorporate various coordinate systems in the construction of 2 D geometrical shapes. (Fundamentals)
210123.0104 Students will be able to calculate the x and y coordinates given a radius and angle. (Fundamentals)
210123.0105 Students will be able to produce 2D sketches using available sketching features. (Object Construction)
210123.0106 Students will be able to apply editing techniques to produce accurate sketches. (Object Construction)
210123.0107 Student will be able to understand and apply sketch constraints. (Object Construction)
210123.0108 Students will analyze drawings with appropriate inquiry functions. (Object Construction)
210123.0109 Students will be able to define sketched objects with dimensions and geometric constraints. (Parts Modeling)
210123.0110 Students will be able to apply necessary sketched features to generate a solid model. (Parts Modeling)
210123.0111 Students will be able to demonstrate the application and modifying of placed features. (Parts Modeling)

210123.0112 Students will be able to develop multi-view drawings such as top, front, right side, isometric, section, and auxiliary views from the solid model. (Creation of Drawing Views)
210123.0113 Students will be able to demonstrate the proper application of annotations and reference dimensions while conforming to established drafting standards. (Creation of Drawing Views)
210123.0114 Students will be able to update model and drawing views using revision specification sheets provided by the instructor. (Creation of Drawing Views)
210123.0115 Students will be able to create assembly models through the integration of individual parts and sub-assemblies. (Assembly Modeling)
210123.0116 Students will be able to generate an assembly drawing, which include Views, Balloons, and Bill Of Materials (BOM). (Assembly Modeling)
210123.0117 Students will be able to recognize the wide array of industry-wide prototyping methods in use. (Rapid Prototyping)
210123.0118 Students will identify the need for rapid-prototyping. (Rapid Prototyping)
210123.0119 Students will prepare a prototype model from a drawing database. (Rapid Prototyping)

210123.02 COMPUTER NUMERICAL CONTROL (CNC) EQUIPMENT: STUDENTS DEVELOP AN UNDERSTANDING OF THE OPERATING PROCEDURES AND PROGRAMMING CAPABILITIES OF MACHINE TOOLS.

210123.0201 Students will be able to explain the history of Computer Controlled Machines charting the growth of NC and how it has been implemented into Private Industry. (The History of Programmable machines)
210123.0202 Students will be able to explain how the application of CNC machines has impacted manufacturing. (The History of Programmable machines)
210123.0203 Students will be able to explain the advantages and disadvantages of CNC Machining. (The History of Programmable machines)
210123.0204 Students will be able to chart the evolution of machine tools, controllers, and software used in programmable machines. (The History of Programmable machines)
210123.0205 Students will explore career opportunities and educational requirements within the field of programmable machines. (The History of Programmable machines)
210123.0206 Students will identify the axis relative to various CNC machines. (CNC Characteristics)
210123.0207 Students will contrast open and closed loop control systems. (CNC Characteristics)
210123.0208 Students will identify the types of drive systems used in CNC machines. (CNC Characteristics)
210123.0209 Students will be able to use the CNC control program to indicate the machine position and then contrast that position to the relative position of the part origin (PRZ). (CNC Characteristics)
210123.0210 Students will be able to identify and explain the function of the major components of a CNC machine tool. (CNC Characteristics)
210123.0211 Students will examine and apply various work holding devices commonly used for CNC machining. (CNC Characteristics)
210123.0212 Students will identify various types of tool changers used in CNC machine tools. (CNC Characteristics)
210123.0213 Students will define the three primary axes used in CNC machining and explore the remaining axes used in advanced machining. (CNC Characteristics)

210123.0214 Students will explain the importance of cutting tool materials and how they affect the speed and feed rates used by machine tools. (CNC Characteristics)
210123.0215 Students will examine different types of tool holding devices used in CNC machine tools. (CNC Characteristics)
210123.0216 Students will be able to select appropriate cutting tools to efficiently, safely and accurately cut parts using a CNC machine. (CNC Characteristics)
210123.0217 Students will understand the difference between reference and position points. (CNC Programming)
210123.0218 Students will understand that CNC machine movements are identified by axes. (CNC Programming)
210123.0219 Students will understand that the axis system is a worldwide standard for machine movement. (CNC Programming)
210123.0220 Students will be able to plot points using absolute, relative (incremental) and polar coordinates. (CNC Programming)
210123.0221 Students will be able to identify Significant Points on geometric shapes (ex. Center point, end point). (CNC Programming)
210123.0222 Students will be able to identify the optimum location for the Program Reference Zero (PRZ) point. (CNC Programming)
210123.0223 Students will be able to identify the three categories of machine movement: straight line, curved line, and non-regular shape. (CNC Programming)
210123.0224 Students will be able to complete a preliminary planning sheet to identify necessary work holding devices, cutting tools, reference points, machining sequences and safe operation. (CNC Programming)
210123.0225 Students will be able to define the term “Alphanumeric Coding.” (CNC Programming)
210123.0226 Students will be able to define the term “G codes.” (CNC Programming)
210123.0227 Students will be able to define the term “M code.” (CNC Programming)
210123.0228 Students will be able to identify the three sections of a program; Initial Commands, Program Body, and Program End. (CNC Programming)
210123.0229 Students will be able to write a basic NC part program using necessary G and M codes including remarks that describe the function of each code. (CNC Programming)
210123.0230 Students will be able to explore the advantages and disadvantages of shop floor programming as well as off line programming. (CNC Programming)
210123.0231 Students will be able to create a simple NC part program using a text editor and a CAM package. (CNC Programming)
210123.0232 Students will be able to employ a CAD/CAM/CNC software solution to create a part. (CNC Programming)
210123.0233 Students will be able to analyze, identify and correct errors found in NC part program files. (CNC Programming)
210123.0234 Students will be able to use simulation software to graphically verify NC program operation. (CNC Programming)
210123.0235 Students will be able to perform a “Dry Run” to verify the machine setup and program operation. (CNC Programming)
210123.0236 Student will be able to demonstrate the ability to safely setup, maintain and operate a CNC machine center using appropriate documentation and procedures. (CNC Operations)
210123.0237 Students will be able to analyze part geometry to select appropriate cutting tools and fixturing devices needed to create the part using a CNC machine. (CNC Operations)
210123.0238 Students will be able to setup and edit the tool library of a CNC control program providing offset values and tool geometry. (CNC Operations)

210123.0239 Students will be able to calculate and verify appropriate spindle speeds and feed rates specific to each cutting tool utilized in an NC part program. (CNC Operations)
210123.0240 Students will be able to safely and accurately fixture a part in a CNC machine and set the program reference zero (PRZ). (CNC Operations)
210123.0241 Students will be able to verify NC part programs using a simulation software before machining the part on a CNC device. (CNC Operations)
210123.0242 Students will be able to list and demonstrate all possible methods of disabling a CNC machine in the event of an emergency. (CNC Operations)
210123.0243 Students will follow a safety checklist prior to running an NC part program on a CNC machine. See Safety Checklist in Unit 2 of the Appendix. (CNC Operations)
210123.0244 Students will be able to Perform a Dry Run to verify the machine setup and program operation. (CNC Operations)
210123.0245 Students will be able to operate a CNC machine to cut a part to specifications. (CNC Operations)

210123.03 COMPUTER-AIDED MANUFACTURING (CAM): STUDENTS CONVERT COMPUTER-GENERATED GEOMETRY INTO A PROGRAM TO DIRECT THE OPERATION OF CNC MACHINE TOOLS.

210123.0301 Students will be able to measure using standard and metric systems. (Precision Measurement)
210123.0302 Students will be able to convert measurements between metric and standard inch systems. (Precision Measurement)
210123.0303 Students will be able to read technical drawings identifying and understand the dimensional tolerances and limits. (Precision Measurement)
210123.0304 Students will be able to make precision measurements to the degree of accuracy required by plan specification using appropriate instruments. (Precision Measurement)
210123.0305 Students will understand how comparison instruments can be used to check dimensions, compare shapes, indicate centers and check parallel surfaces. (Precision Measurement)
210123.0306 Students will be aware of advanced and automated measurement systems that are applied in industry. (ex. Coordinate Measuring Systems, Digital Probes and Optical Scanners) (Precision Measurement)
210123.0307 Students will be aware of the importance of precision measurement in SPC and quality control. (Precision Measurement)
210123.0308 Students will be able to define the acronym CAM and explain what the purpose of a CAM package is. (CAM Software)
210123.0309 Students will demonstrate their ability to operate the user interface of a CAM package and access help using appropriate documentation and help screens. (CAM Software)
210123.0310 Students will be able to perform basic file operations using a CAM package such as saving, opening, printing and editing part program files. (CAM Software)
210123.0311 Students will demonstrate an ability to import and export CAD files using a CAM package. (CAM Software)
210123.0312 Students will setup a CAM package by editing the material and tool libraries, defining stock sizes, selecting the appropriate post processor and defining the units of measure to be used. (CAM Software)
210123.0313 Students will define and apply the fundamental and advanced milling and turning procedures used in CAM packages. (CAM Software)

210123.0314 Students will use a CAM package to generate and edit tool paths by applying appropriate machining processes to geometry imported from a CAD program. (CAM Software)

210123.04 ROBOTICS: STUDENT PROGRAM ROBOTS TO HANDLE MATERIALS IN ASSEMBLY-LINE OPERATIONS

210123.0401 Students will explore the chronological development of automation leading to robotics. (Introduction To Robotics)
210123.0402 Students will investigate career opportunities in the robotics career fields. (Introduction To Robotics)
210123.0403 Students will demonstrate the development of robotics from Science Fiction. (Introduction To Robotics)
210123.0404 Students will identify a minimum of four dangerous and repetitive jobs that robots are used for. (Introduction To Robotics)
210123.0405 Students will formulate a definition of a robot. (Robotics And Automated Systems)
210123.0406 Students will be able to classify different types of Robots. (Robotics And Automated Systems)
210123.0407 Students will evaluate the positive impact robots have on manufacturing. (Robotics And Automated Systems)
210123.0408 Students will discuss the social implications of robots. (Robotics And Automated Systems)
210123.0409 Students will identify and compare the four classifications of robots. (Robot Characteristics)
210123.0410 Students will investigate a classification of robot. (Robot Characteristics)
210123.0411 Students will design and build a working model of a robot. (Robot Characteristics)
210123.0412 Students will identify and report specifications and work envelopes of robots. (Robot Characteristics)
210123.0413 Students will identify and sketch the mechanical components to a robot. (Mechanical Components)
210123.0414 Students will design and develop an end effector. (Mechanical Components)
210123.0415 Students will demonstrate their understanding of the way end effectors are specific to a process. (Mechanical Components)
210123.0416 Students will understand the various drive systems used in robotics and analyze the advantages and disadvantages of each. (Mechanical Components)
210123.0417 Students will understand the basic components of robot controllers. (Control Systems)
210123.0418 Students will demonstrate an understanding of control techniques and computer simulations. (Control Systems)
210123.0419 Students will design and build a feed system with sensors. (Control Systems)
210123.0420 Students will program a robot to perform several tasks. (Programming Methods)
210123.0421 Students will program a robot to solve a materials handling problem. (Programming Methods)
210123.0422 Students will recognize the need for end of arm tooling and how this tooling affects the robots operation. (Programming Methods)
210123.0423 Students will understand the necessity for specialty tooling applications in robotics. (Industrial Robot Applications)
210123.0424 Students will prepare and document a presentation on end of arm tooling. (Industrial Robot Applications)

210123.0425 Students will analyze and generate the solution to a robotic manufacturing problem. (Industrial Robot Applications)

210123.05 FLEXIBLE MANUFACTURING SYSTEMS: TEAMS OF STUDENTS DESIGN MANUFACTURING WORK CELLS AND TABLETOP FACTORIES TO SOLVE COMPLEX PROBLEMS THAT ARISE IN INTEGRATING MULTIPLE PIECES OF COMPUTER-CONTROLLED EQUIPMENT.

210123.0501 Students will understand how the individual components of a flexible manufacturing system are interrelated. (Rationale for CIM Manufacturing)
210123.0502 Students will recognize the benefits and problems associated with CIM technology and how they affect the manufacturing process. (Rationale for CIM Manufacturing)
210123.0503 Students will identify some basic characteristics of a manufacturing operation that lend themselves to computer integrated manufacturing. (Rationale for CIM Manufacturing)
210123.0504 Students will identify some of the typical components and sub systems that make up an automated machining, assembly and process-type manufacturing operation. (Rationale for CIM Manufacturing)
210123.0505 Student will identify the three categories of CIM manufacturing systems. (Types of CIM Systems)
210123.0506 Students will compare and contrast the benefits and drawbacks of the three categories of CIM manufacturing systems. (Types of CIM Systems)
210123.0507 Students will recognize the working relationship between the CNC mill and the robot. (Types of CIM Systems)
210123.0508 The students will be able to identify the components of a FMS. (Types of CIM Systems)
210123.0509 Students will identify and study the relationship between a CNC milling machine interface and a jointed arm robot interface through a communication handshaking process. (Components of SIM Systems)
210123.0510 Students will explore the individual components used in selected CIM systems. (Components of SIM Systems)
210123.0511 Students will analyze and select components for a CIM system for a specific industrial application. (Components of SIM Systems)
210123.0512 Students will understand the various applications of a Programmable Logic Controller as related to its use in a CIM system. (Components of SIM Systems)
210123.0513 Students will understand the difference between a PLC and a computer with interface. (Components of SIM Systems)
210123.0514 Students will recognize and understand the necessary safety precautions associated with a fully automated CIM system. (CIM Systems Applications)
210123.0515 Students will recognize and explain the significance of teamwork and communication when they combine the designs of the individual groups into a complete miniature FMS. (CIM Systems Applications)
210123.0516 Students will demonstrate how their individual components work together to form a complete CIM system. (CIM Systems Applications)
210123.0517 Students will assemble and test their individual component designs by integrating them into a complete miniature FMS built from the Fischertechnik models. (CIM Systems Applications)